

WHAT IS CLAIMED IS:

1. An apparatus for use with a three-dimensional object having a feature and an optical scanner having a scanning surface, the apparatus comprising:

5 a mounting structure adapted to be disposed on the scanner, said mounting structure having a calibration mark adapted for being read by the scanner, said mounting structure further being adapted to position the object so that the object is adjacent to the scanning surface of the scanner and at a first pre-determined distance from the calibration mark.

10 2. The apparatus of claim 1 wherein the mounting structure is adapted to removably abut the optical scanner.

15 3. The apparatus of claim 2 wherein the mounting structure comprises an alignment surface adapted to abut the object, the alignment surface being disposed at a second pre-determined distance from the calibration mark.

20 4. The apparatus of claim 3 wherein the alignment surface is adapted to abut the object at a point spaced apart from the scanning surface.

5. The apparatus of claim 4 wherein the alignment surface is one of generally cylindrical and generally spherical in shape.

25 6. The apparatus of claim 5 wherein the mounting structure further comprises: a first frame member having a bottom surface and a top surface, the bottom surface adapted for placement on the scanning surface of the scanner, and the top surface adapted for receiving the object; and

a second frame member having a proximate end and a distal end, the proximate end being joined with the first frame member and the alignment surface being disposed on the distal end.

5 7. The apparatus of claim 3 further comprising a computer adapted to receive data from the optical scanner.

8. An apparatus for measuring a feature on a side of a wafer carrier, comprising:
an optical scanner having a scanning surface; and
10 a mounting structure disposed on said scanner and configured to position said wafer carrier over said scanner surface, said structure having a first calibration mark adapted to be read by the scanner and having an alignment surface adapted for engagement with the wafer carrier.

15 9. The apparatus of claim 8 wherein the mounting structure is adapted to removably abut the optical scanner.

20 10. The apparatus of claim 8 wherein the wafer carrier side has an alignment pin having a length and wherein the mounting structure is further adapted to position the wafer carrier so that the carrier side is in a generally parallel, spaced-apart relationship with the scanning surface of the scanner by a distance that is greater than the length of the alignment pin.

11. The apparatus of claim 8 wherein the optical scanner has a scan head adapted to move in a scanning direction, the apparatus further comprising:

a second calibration mark located on the mounting structure and adapted for being read by the scanner, the second calibration mark located at a first pre-determined distance from the first calibration mark, the second calibration mark and the first calibration mark defining a line running generally parallel to the scanning direction.

12. The apparatus of claim 8 wherein the optical scanner has a scan head adapted to move in a scanning direction, the apparatus further comprising:

a second calibration mark located on the mounting structure and adapted for being read by the scanner, the second calibration mark located at a first pre-determined distance from the first calibration mark, the second calibration mark and the first calibration mark defining a line running generally orthogonal to the scanning direction.

13. The apparatus of claim 11 further comprising:

a third calibration mark and a fourth calibration mark, said third and fourth calibration marks located on the mounting structure and adapted for being read by the scanner, the third and fourth calibration marks located at a second pre-determined distance from one another and defining a line running generally orthogonal to the scanning direction.

14. The apparatus of claim 13 wherein the alignment surface is adapted to abut the wafer carrier, the alignment surface being disposed at a third pre-determined distance from one of the first, second, third and fourth calibration marks.

15. The apparatus of claim 8 wherein the alignment surface is adapted to abut the wafer carrier at a point spaced apart from the scanning surface, the alignment surface being disposed at a first pre-determined distance from the first calibration mark.

16. The apparatus of claim 15 wherein the alignment surface is one of generally cylindrical and generally spherical in shape.

17. The apparatus of claim 8 further comprising a computer adapted to receive data from the optical scanner.

18. An apparatus for measuring a feature on a side of a wafer carrier comprising: a mounting structure having an alignment surface adapted for engagement with said carrier, said structure further having a first optical calibration mark.

19. The apparatus of claim 18 having a second optical calibration mark positioned a first pre-determined distance along a first direction from said first calibration mark.

20. The apparatus of claim 19 wherein said structure has a third optical calibration mark and a fourth optical calibration mark positioned at a second pre-determined distance from said third optical calibration mark in a second direction generally orthogonal to the first direction.

21. An apparatus for measuring a feature on a side of a wafer carrier comprising: an optical scanner having a scanning surface; a first frame member having a bottom surface and a top surface, the bottom surface being adapted for placement on the scanning surface of the scanner, and the top surface being adapted for receiving the wafer carrier side; a second frame member having a proximate end and a distal end, the proximate end being joined with the first frame member; a generally cylindrically-shaped alignment surface disposed at the distal end of the second frame member and adapted to abut the wafer carrier; a brace member secured to the first and the second frame members; and

a first calibration mark on the bottom surface of the first frame member and adapted to being read by the scanner, the first calibration mark positioned at a first pre-determined distance from the alignment surface.

5 22. The apparatus of claim 21 further comprising a second calibration mark on the bottom surface of the first frame member and adapted to being read by the scanner, the second calibration mark positioned at a second pre-determined distance from the first calibration mark.

10 23. The apparatus of claim 21 wherein the alignment surface is adapted to abut the wafer carrier at a point spaced apart from the scanning surface.

15 24. A method of measuring a feature on a side of a wafer carrier comprising the steps of:

 placing a mounting structure on a scanning surface of an optical scanner, the mounting structure having a calibration mark adapted to being scanned; placing the wafer carrier on the mounting structure so that the carrier side is adjacent to the scanning surface; scanning the calibration mark and at least a portion of the carrier side with the optical scanner; and determining a value representing the distance between the calibration mark and the feature on the wafer carrier side.

20 25. A method of measuring a feature of a wafer carrier comprising the steps of: operating an optical scanner to obtain an image comprising:

 a first image portion representing a first location point on the wafer carrier; and

 a second image portion representing a second location point; and

 calculating a first value from the image, the first value representing the distance between the first location point and the second location point.

26. The method of claim 25 wherein the image further comprises a third image portion representing a third location point and a fourth image portion representing a fourth location point, and wherein the third and fourth location points represent positions on other than the wafer carrier, the method further comprising:

calculating a second value from the image, the second value representing the distance between the third and fourth location points; and
calibrating the optical scanner with the second value.

27. The method of claim 26 wherein the step of calibrating the optical scanner comprises measuring the pixel resolution of the scanner.

28. The method of claim 26 wherein the step of calibrating the optical scanner comprises measuring the scan line resolution of the scanner.

29. The method of claim 25 wherein the step of calculating the first value is comprised of performing a numerical best fit of the image of the first and second location points.

30. An apparatus for measuring a feature on a side of a wafer carrier comprising:
means for obtaining an image;
means for positioning the wafer carrier so that the carrier side is adjacent to the image obtaining means; and
a calibration mark on the positioning means and adapted to being read by the image obtaining means.

31. The apparatus of claim 30 further comprising means for positioning the wafer carrier at a pre-determined distance from the calibration mark.

32. The apparatus of claim 31 further comprising a plurality of additional calibration marks on the positioning means and adapted to being read by the image obtaining means, the additional calibration marks being at a plurality of additional pre-determined distances from one another.

33. An apparatus for measuring a feature of a wafer carrier, the apparatus comprising:

means for obtaining an image comprising:

a first image portion representing a first location point on the wafer carrier;

and

a second image portion representing a second location point; and

means for calculating a first value from the image, the first value representing the distance between the first location point and the second location point.

34. The apparatus of claim 33 wherein the second location point represents a location on other than the wafer carrier.

35. The apparatus of claim 33 wherein the image further comprises a third image portion representing a third location point and a fourth image portion representing a fourth location point, and wherein the third and fourth location points represent positions on other than the wafer carrier, the apparatus further comprising:

means for calculating a second value from the image, the second value representing

the distance between the third and fourth location points; and

means for calibrating the image obtaining means using the second value.

36. A method of measuring a feature of a wafer carrier, comprising the steps of: receiving data representing an image comprising:

a first image portion representing a first location point on the wafer carrier;

and

a second image portion representing a second location point; and

calculating a value from the image, the value representing the distance between the first location point and the second location point.

37. The method of claim 36 wherein the first location point is a base of a front opening of the wafer carrier and the second location point is a location other than on the wafer carrier.

38. The method of claim 36 wherein the first location point is a center line of a first slot end wall and the second location point is the center line of a second slot end wall.

39. The method of claim 36 wherein the first location point is an end wall of one slot tooth measured at one side of an opening of the wafer carrier and the second location point is an end wall of a corresponding opposed slot tooth measured at the other side of the wafer carrier opening, and wherein the value is a slot root.

40. The method of claim 36 wherein the first location point is a first point on a slot tooth and the second location point is a second point on the slot tooth, and wherein the wafer carrier feature is a profile of the slot tooth.

41. The method of claim 36 wherein the first location point is a first point on a slot tooth and the second location point is a second point on the slot tooth, and wherein the wafer carrier feature is a slant angle of the slot tooth.

42. The method of claim 36 wherein the first location point is a base of a front opening of the wafer carrier and the second location point is a centerline of a slot tooth end wall.

43. A method of analyzing a wafer carrier comprising the steps of:
receiving data representing an image of a feature of the wafer carrier;

calculating a first value from the image, the first value corresponding to the wafer carrier feature;
retrieving a second value, the second value being derived from other than the image;
and
5 comparing the first value with the second value.

44. A method of analyzing at least one wafer carrier comprising the steps of:
receiving a first set of data representing a first image of a feature of a first wafer carrier;
10 calculating a first value from the first set of data, the first value corresponding to the first wafer carrier feature; and
storing the first value in a computer readable medium.

45. The method of claim 44 further comprising:
15 receiving additional data corresponding to an identification number for the first wafer carrier;
storing the additional data in the computer readable medium; and
associating the additional data with the first value.

20 46. The method of claim 45 wherein the additional data is derived from a bar code.

47. The method of claim 44 further comprising:
retrieving the first value from the computer readable medium; and
providing the first value for use by one of a wafer handling tool and a wafer carrier
25 handling tool.

48. The method of claim 44 further comprising:
receiving a second set of data representing a second image of the feature of a second
wafer carrier;
5 calculating a second value from the second set of data, the second value
corresponding to the feature of the second wafer carrier; and
storing the second value in the computer readable medium.

49. The method of claim 48 further comprising:
10 retrieving the first and second values from the computer readable medium; and
performing statistical analysis using the first and second values.

50. The method of claim 48 further comprising:
receiving a plurality of sets of additional data representing a plurality of additional
15 images of features of a plurality of additional wafer carriers;
calculating a plurality of additional values from the plurality of additional sets of data,
the plurality of additional values corresponding to the plurality of features of
the additional wafer carriers;
storing the plurality of additional values in the computer readable medium; and
20 calculating a final value as a function of the first value, the second value and the
plurality of additional values.

51. The method of claim 50 wherein the final value corresponds to one of a mean
value, an average value and a median value.

52. The method of claim 50 further comprising:
receiving a follow-up set of data representing a follow-up image of the feature of a
follow-up wafer carrier;
calculating a follow-up value from the follow-up set of data, the follow-up value
30 corresponding to the follow-up wafer carrier feature; and

comparing the follow-up value with the final value.

53. The method of claim 50 further comprising:

providing the final value for use by one of a wafer handling tool and a wafer carrier
5 handling tool.

54. A method of measuring a mounting structure comprising the steps of:

receiving data corresponding to an image representing a plurality of calibration marks
on the mounting structure;

10 determining a first geometric shape formed by the calibration marks; and

comparing the first geometric shape with a second geometric shape.

55. A system for analyzing a wafer carrier, comprising:

a processing unit capable of executing software routines; and

15 program logic executed by the processing unit, comprising:

means for receiving data representing an image comprising:

a first image portion representing a first location point on the wafer
carrier; and

a second image portion representing a second location point; and

20 means for calculating a value from the image, the value representing the
distance between the first location point and the second location point.

56. The system of claim 55 wherein the first location point is a base of a front
opening of the wafer carrier and the second location point is a location other than on the
25 wafer carrier.

57. The system of claim 55 wherein the first location point is a center line of a
first slot end wall and the second location point is the center line of a second slot end wall.

58. The system of claim 55 wherein the first location point is an end wall of one slot tooth measured at one side of an opening of the wafer carrier and the second location point is an end wall of a corresponding opposed slot tooth measured at the other side of the wafer carrier opening, and wherein the value is a slot root.

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59. The system of claim 55 wherein the first location point is a first point on a slot tooth and the second location point is a second point on the slot tooth, and wherein the wafer carrier feature is a profile of the slot tooth.

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60. The system of claim 55 wherein the first location point is a first point on a slot tooth and the second location point is a second point on the slot tooth, and wherein the wafer carrier feature is a slant angle of the slot tooth.

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61. The system of claim 55 wherein the first location point is a base of a front opening of the wafer carrier and the second location point is a centerline of a slot tooth end wall.

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62. A system for analyzing a wafer carrier, comprising:
a processing unit capable of executing software routines; and
program logic executed by the processing unit, comprising:

means for receiving data representing an image of a feature of the wafer carrier;

means for calculating a first value from the image, the first value corresponding to the wafer carrier feature;

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means for retrieving a second value, the second value being derived from other than the image; and

means for comparing the first value with the second value.

63. A system for analyzing a wafer carrier, comprising:
a processing unit capable of executing software routines; and
program logic executed by the processing unit, comprising:
means for receiving a first set of data representing a first image of a feature of
a first wafer carrier;
means for calculating a first value from the first set of data, the first value
corresponding to the first wafer carrier feature; and
means for storing the first value in a computer readable medium.
64. The system of claim 63 further comprising:
means for receiving additional data corresponding to an identification number
for the first wafer carrier;
means for storing the additional data in the computer readable medium; and
means for associating the additional data with the first value.
65. The system of claim 64 wherein the additional data is derived from a bar code.
66. The system of claim 63 further comprising:
means for retrieving the first value from the computer readable medium; and
means for providing the first value for use by one of a wafer handling tool and
a wafer carrier handling tool.
67. The system of claim 63 further comprising:
means for receiving a second set of data representing a second image of the
feature of a second wafer carrier;
means for calculating a second value from the second set of data, the second
value corresponding to the feature of the second wafer carrier; and
means for storing the second value in the computer readable medium.

68. The system of claim 67 further comprising:
means for retrieving the first and second values from the computer readable
medium; and
means for performing statistical analysis using the first and second values.

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69. The system of claim 67 further comprising:
means for receiving a plurality of sets of additional data representing a
plurality of additional images of features of a plurality of additional
wafer carriers;
means for calculating a plurality of additional values from the plurality of
additional sets of data, the plurality of additional values corresponding
to the plurality of features of the additional wafer carriers;
means for storing the plurality of additional values in the computer readable
medium; and
means for calculating a final value as a function of the first value, the second
value and the plurality of additional values.

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70. The system of claim 69 wherein the final value corresponds to one of a mean
value, an average value and a median value.

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71. The system of claim 69 further comprising:
means for receiving a follow-up set of data representing a follow-up image of
the feature of a follow-up wafer carrier;
means for calculating a follow-up value from the follow-up set of data, the
follow-up value corresponding to the follow-up wafer carrier feature;
and
means for comparing the follow-up value with the final value.

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72. The system of claim 69 further comprising:
means for providing the final value for use by one of a wafer handling tool
and a wafer carrier handling tool.

5 73. A system for measuring a mounting structure, comprising:
a processing unit capable of executing software routines; and
program logic executed by the processing unit, comprising:
means for receiving data corresponding to an image representing a plurality of
calibration marks on the mounting structure;
10 means for determining a first geometric shape formed by the calibration
marks; and
means for comparing the first geometric shape with a second geometric shape.

74. An article of manufacture for use in analyzing a wafer carrier, the article of
15 manufacture comprising a computer usable media including at least one computer program
embedded therein that causes the computer to perform:
receiving data representing an image comprising:
a first image portion representing a first location point on the wafer carrier;
and
20 a second image portion representing a second location point; and
calculating a value from the image, the value representing the distance between the
first location point and the second location point.

75. The article of manufacture of claim 74 wherein the first location point is a
25 base of a front opening of the wafer carrier and the second location point is a location other
than on the wafer carrier.

76. The article of manufacture of claim 74 wherein the first location point is a
center line of a first slot end wall and the second location point is the center line of a second
30 slot end wall.

77. The article of manufacture of claim 74 wherein the first location point is an end wall of one slot tooth measured at one side of an opening of the wafer carrier and the second location point is an end wall of a corresponding opposed slot tooth measured at the other side of the wafer carrier opening, and wherein the value is a slot root.

78. The article of manufacture of claim 74 wherein the first location point is a first point on a slot tooth and the second location point is a second point on the slot tooth, and wherein the wafer carrier feature is a profile of the slot tooth.

79. The article of manufacture of claim 74 wherein the first location point is a first point on a slot tooth and the second location point is a second point on the slot tooth, and wherein the wafer carrier feature is a slant angle of the slot tooth.

80. The article of manufacture of claim 74 wherein the first location point is a base of a front opening of the wafer carrier and the second location point is a centerline of a slot tooth end wall.

81. An article of manufacture for use in analyzing a wafer carrier, the article of manufacture comprising a computer usable media including at least one computer program embedded therein that causes the computer to perform:

receiving data representing an image of a feature of the wafer carrier;

calculating a first value from the image, the first value corresponding to the wafer carrier feature;

retrieving a second value, the second value being derived from other than the image;

and

comparing the first value with the second value.

82. An article of manufacture for use in analyzing at least one wafer carrier, the article of manufacture comprising a computer usable media including at least one computer program embedded therein that causes the computer to perform:

receiving a first set of data representing a first image of a feature of a first wafer carrier;

calculating a first value from the first set of data, the first value corresponding to the first wafer carrier feature; and

storing the first value in a computer readable medium.

83. The article of manufacture of claim 82 further comprising:

receiving additional data corresponding to an identification number for the first wafer carrier;

storing the additional data in the computer readable medium; and

associating the additional data with the first value.

84. The article of manufacture of claim 83 wherein the additional data is derived from a bar code.

85. The article of manufacture of claim 82 further comprising:

retrieving the first value from the computer readable medium; and

providing the first value for use by one of a wafer handling tool and a wafer carrier handling tool.

86. The article of manufacture of claim 82 further comprising:

receiving a second set of data representing a second image of the feature of a second wafer carrier;

calculating a second value from the second set of data, the second value corresponding to the feature of the second wafer carrier; and

storing the second value in the computer readable medium.

87. The article of manufacture of claim 86 further comprising:
retrieving the first and second values from the computer readable medium; and
performing statistical analysis using the first and second values.

5 88. The article of manufacture of claim 86 further comprising:
receiving a plurality of sets of additional data representing a plurality of additional
images of features of a plurality of additional wafer carriers;
calculating a plurality of additional values from the plurality of additional sets of data,
the plurality of additional values corresponding to the plurality of features of
10 the additional wafer carriers;
storing the plurality of additional values in the computer readable medium; and
calculating a final value as a function of the first value, the second value and the
plurality of additional values.

15 89. The article of manufacture of claim 88 wherein the final value corresponds to
one of a mean value, an average value and a median value.

20 90. The article of manufacture of claim 88 further comprising:
receiving a follow-up set of data representing a follow-up image of the feature of a
follow-up wafer carrier;
calculating a follow-up value from the follow-up set of data, the follow-up value
corresponding to the follow-up wafer carrier feature; and
comparing the follow-up value with the final value.

25 91. The article of manufacture of claim 88 further comprising:
providing the final value for use by one of a wafer handling tool and a wafer carrier
handling tool.

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determining a first geometric shape formed by the calibration marks; and
comparing the first geometric shape with a second geometric shape.